

WHAT IS CLAIMED IS:

1. A method of treatment of a contaminate contaminated with an organic compound, comprising the steps of:
 - (a) providing a contaminate, wherein the contaminate is contaminated with an organic compound;
 - (b) treating the contaminate with a bioremediation step; wherein the bioremediation step comprises contacting the contaminate with a microbial consortium under conditions suitable for the microbial consortium to mediate solubilization or biodegradation of the organic compound or reaction products thereof; and
 - (c) subsequently treating the contaminate with a chemical oxidation step; wherein the chemical oxidation step comprises: contacting the bioremediated contaminate with (i) a transition metal in soluble form; (ii) a chelator of the transition metal, wherein the chelator and the transition metal form a transition metal:chelator complex; (iii) an oxidizing agent that provides a reactive free radical in the presence of the complex; and (iv) a buffering salt to maintain the pH in the neutral range; wherein the reactive free radical initiates a chemical reaction with the organic compound to produce reaction products of the organic compound.
2. The method of claim 1, wherein said neutral pH range is maintained to sustain said microbial consortium.
3. The method of claim 1, wherein said neutral pH range is maintained to inhibit solubilization of heavy metal co-contaminants.
4. The method of claim 1, wherein the contaminate is a particulate material, a surface soil, a subsurface soil, a sand, a silt, a clay, a sediment, a loam, a slurry, a colloid, a liquor, an industrial water fluid, ground water, a pool, a pond or a lake.
5. The method of claim 4, wherein the particulate material is gravel, pebbles, stone, chips, rock, ore, mining waste, coal, coke, slag, concrete, brick, construction material, demolition material, vermiculite, synthetic resin or plastic.

6. The method of claim 1, wherein the contaminating organic compound is selected from the group consisting of a polycyclic compound, an aromatic compound, a polycyclic aromatic compound, an aliphatic compound, an olefinic compound and an ethynic compound.
7. The method of claim 6, wherein the contaminating organic compound is a polycyclic aromatic compound.
8. The method of claim 7, wherein the polycyclic aromatic compound is selected from the group consisting of naphthalene, fluorene, phenanthrene, anthracene, pyrene, chrysene and benzo(a)pyrene.
9. The method of claim 1, wherein the transition metal is manganese, iron, cobalt, nickel, copper or zinc.
10. The method of claim 9, wherein the transition metal is iron.
11. The method of treatment according to claim 10, wherein the iron is present as ferrous iron, Fe(II), or ferric iron, Fe(III).
12. The method of treatment according to claim 11, wherein the iron is present as a perhalate.
13. The method of treatment according to claim 12, wherein the perhalate is a perchlorate, a perbromate or a periodate.
14. The method of treatment according to claim 13 wherein the perhalate is a perchlorate.
15. The method of treatment according to claim 1, wherein the chelator of the transition metal is an iron-chelator compound.

16. The method of treatment according to claim 15, wherein the iron-chelator compound is a hydroxylated benzene, a hydroxylated benzoic acid, a nitrilotriacetic acid, or a diethylenetriaminepentaacetic acid.

17. The method of treatment according to claim 16, wherein the hydroxylated benzene is a dihydroxybenzene or a trihydroxybenzene.

18. The method of treatment according to claim 17, wherein the hydroxylated benzene is a dihydroxybenzene.

19. The method of treatment according to claim 18, wherein the dihydroxybenzene is catechol.

20. The method of treatment according to claim 16, wherein the hydroxylated benzoic acid is gallic acid.

21. The method of treatment according to claim 16, wherein the hydroxylated benzoic acid is salicylic acid.

22. The method of treatment according to claim 1, wherein the pH is maintained in the range from about pH 5 to about pH 8.

23. The method of treatment according to claim 22, wherein the pH is maintained in the range from about pH 5.5 to about pH 7.

24. The method of treatment according to claim 23, wherein the pH is maintained in the range from about pH 6 to about pH 6.5.

25. The method of treatment according to claim 1, wherein the oxidizing agent is a peroxide.

26. The method of treatment according to claim 25, wherein the peroxide is hydrogen peroxide.
27. The method of treatment according to claim 1, wherein the reactive free radical comprises an oxygen radical.
28. The method of treatment according to claim 1, wherein the organic compound of the contaminate is insoluble in aqueous solution.
29. The method of treatment according to claim 1, wherein the reaction products are soluble in aqueous solution.
30. The method of treatment according to claim 1, wherein at least one of the reaction products of the organic compound is bioavailable to the microbial consortium.
31. The method of treatment according to claim 1, wherein the oxidizing agent produces an oxygen radical.
32. The method of treatment according to claim 1, wherein the buffering salt is a salt with a pKa in the neutral range.
33. The method of treatment according to claim 32, wherein the buffering salt is a salt with a pKa in the range from about 5 to about 8.
34. The method of treatment according to claim 33, wherein the buffering salt is calcium carbonate.
35. The method of treatment according to claim 1, wherein the molecular weight of the organic compound of the contaminate is reduced.

36. The method of treatment according to claim 35, wherein the organic compound of the contaminate is substantially mineralized to carbon dioxide and water.
37. The method of treatment according to claim 1, wherein the organic compound of the contaminate is toxic or carcinogenic to animals.
38. The method of treatment according to claim 37, wherein the organic compound of the contaminate is toxic or carcinogenic to humans.
39. The method of treatment according to claim 1, wherein the reaction products are non-toxic to animals.
40. The method of treatment according to claim 39, wherein the reaction products are non-toxic to humans.
41. The method of treatment according to claim 1, wherein treating with the microbial consortium yields at least one biodegradation reaction product, and wherein the products of biodegradation are non-toxic to animals.
42. The method of treatment according to claim 41, wherein the products of biodegradation are non-toxic to humans.
43. The method of treatment according to claim 1, wherein the reaction products are not known to be carcinogenic in animals.
44. The method of treatment according to claim 43, wherein the reaction products are not known to be carcinogenic in humans.
45. The method of treatment according to claim 41, wherein the biodegradation products are not known to be carcinogenic in animals.

46. The method of treatment according to claim 45, wherein the biodegradation products are not known to be carcinogenic in humans.

47. The method of treatment according to claim 1, wherein the organic compound of the contaminate is from industrial manufacturing, industrial processing, chemical processing, coal tar processing, oil refining or energy generation.

48. The method of treatment according to claim 1, wherein the organic compound of the contaminate is from a natural process.

49. The method of treatment according to claim 1, wherein the organic compound of the contaminate is halogenated.

50. The method of treatment according to claim 49, wherein the halogenated organic compound of the contaminate is selected from the group consisting of a trichlorethene compound, a perchlorethene compound and a polychlorinated-biphenyl compound.

51. The method of treatment according to claim 1, wherein the microbial consortium comprises at least one of the following: a bacterial species, a fungal species and an actinomyces species.

52. The method of treatment according to claim 1, wherein the microbial consortium is known to degrade the organic compound of the contaminant.

53. The method of treatment according to claim 1, wherein the microbial consortium comprises at least one of the following: an *Alcaligenes* species, a *Sphingomonas* species, a *Pseudomonas* species, a *Rhodotorula* species, a *Burkholderia* species, an *Ochrobactrum* species, a *Rhodococcus* species, a *Xanthomonas* species and an *Actinomyces* species.